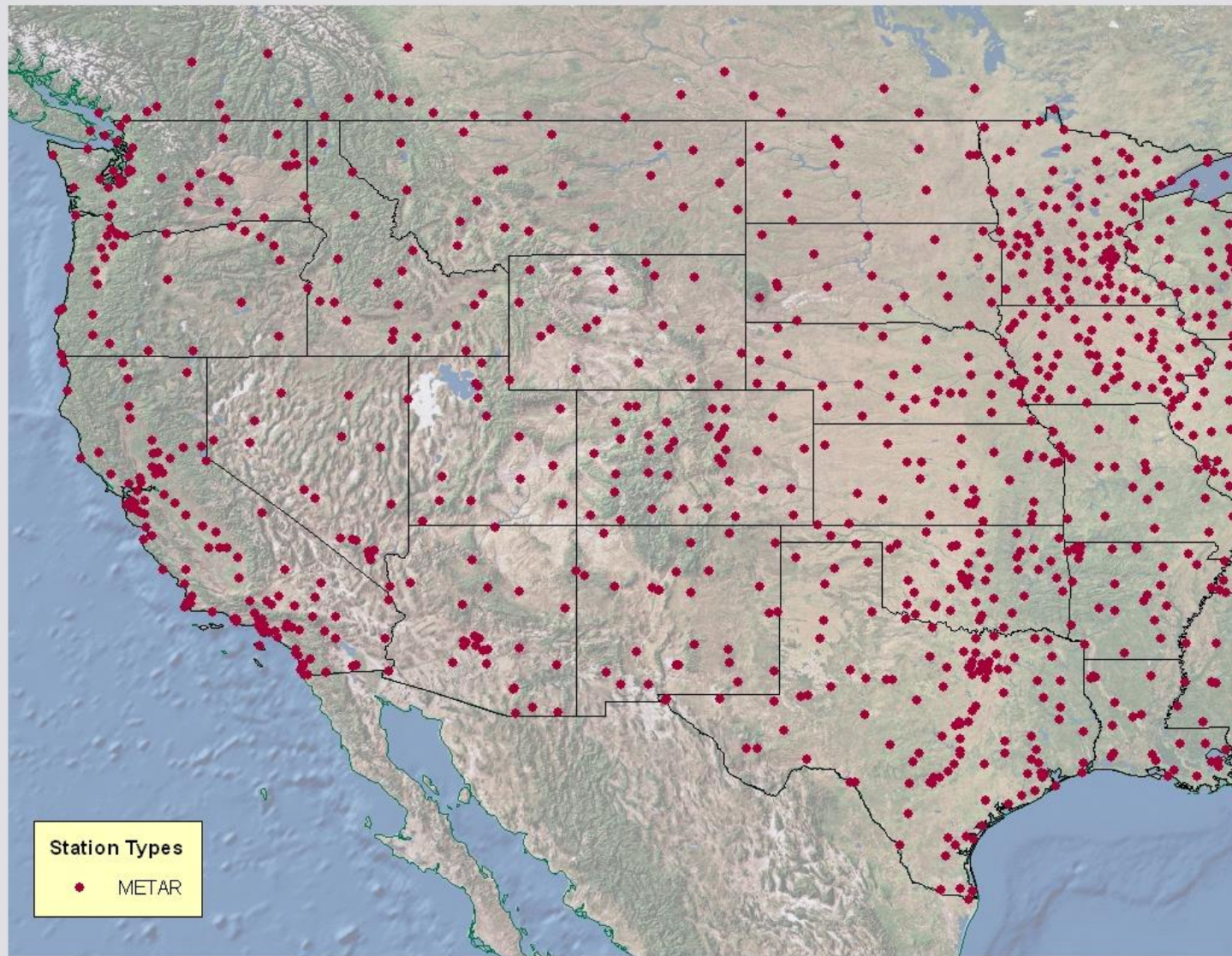


GRIDDED MOS

- STARTS WITH POINT (STATION) MOS
 - Essentially the same MOS that is in text bulletins
 - Number and type of stations differ for different weather elements

MOS Stations available to analysis

METAR

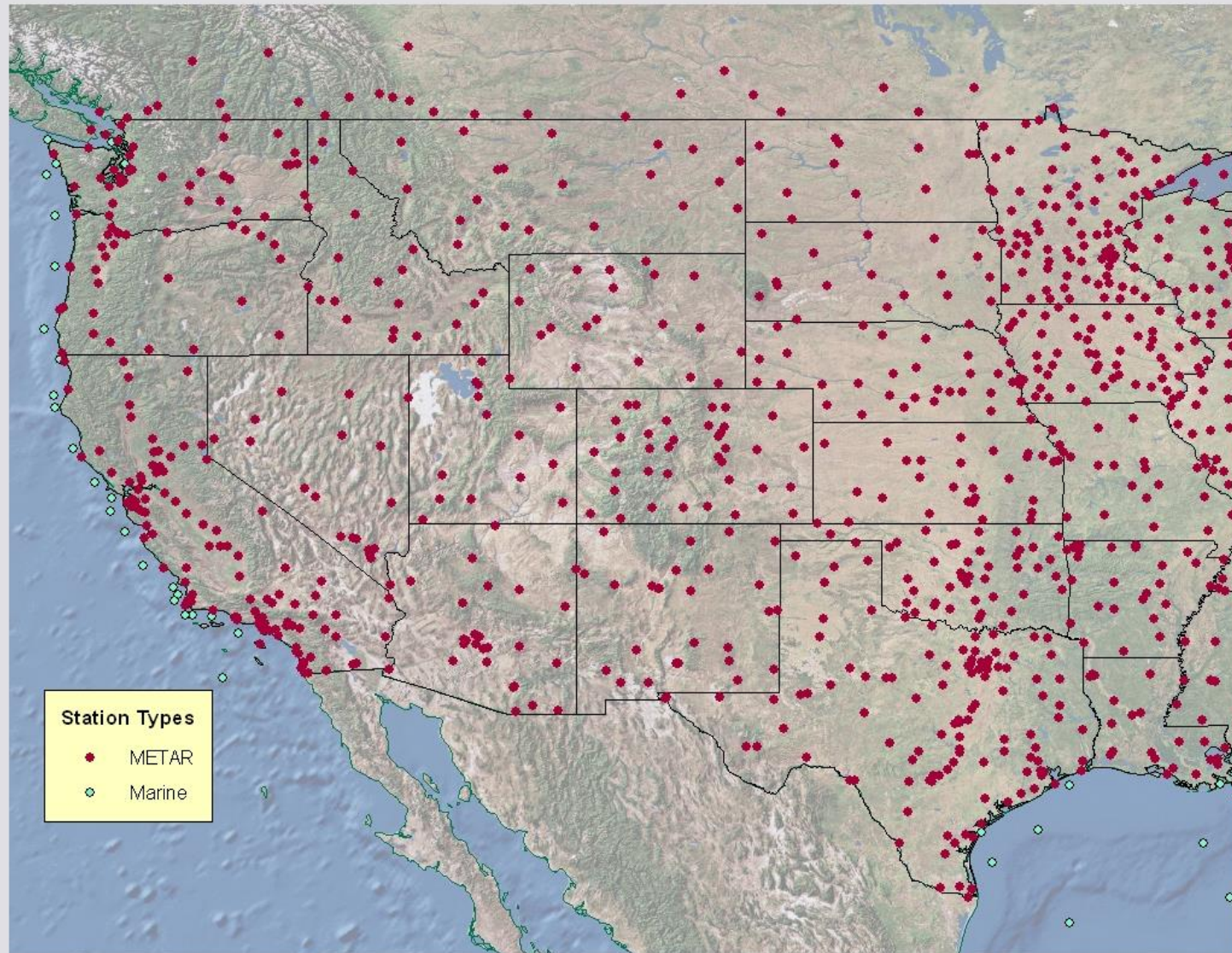


Elements

- Probability of Precipitation
- QPF

MOS Stations available to analysis

METAR, Marine

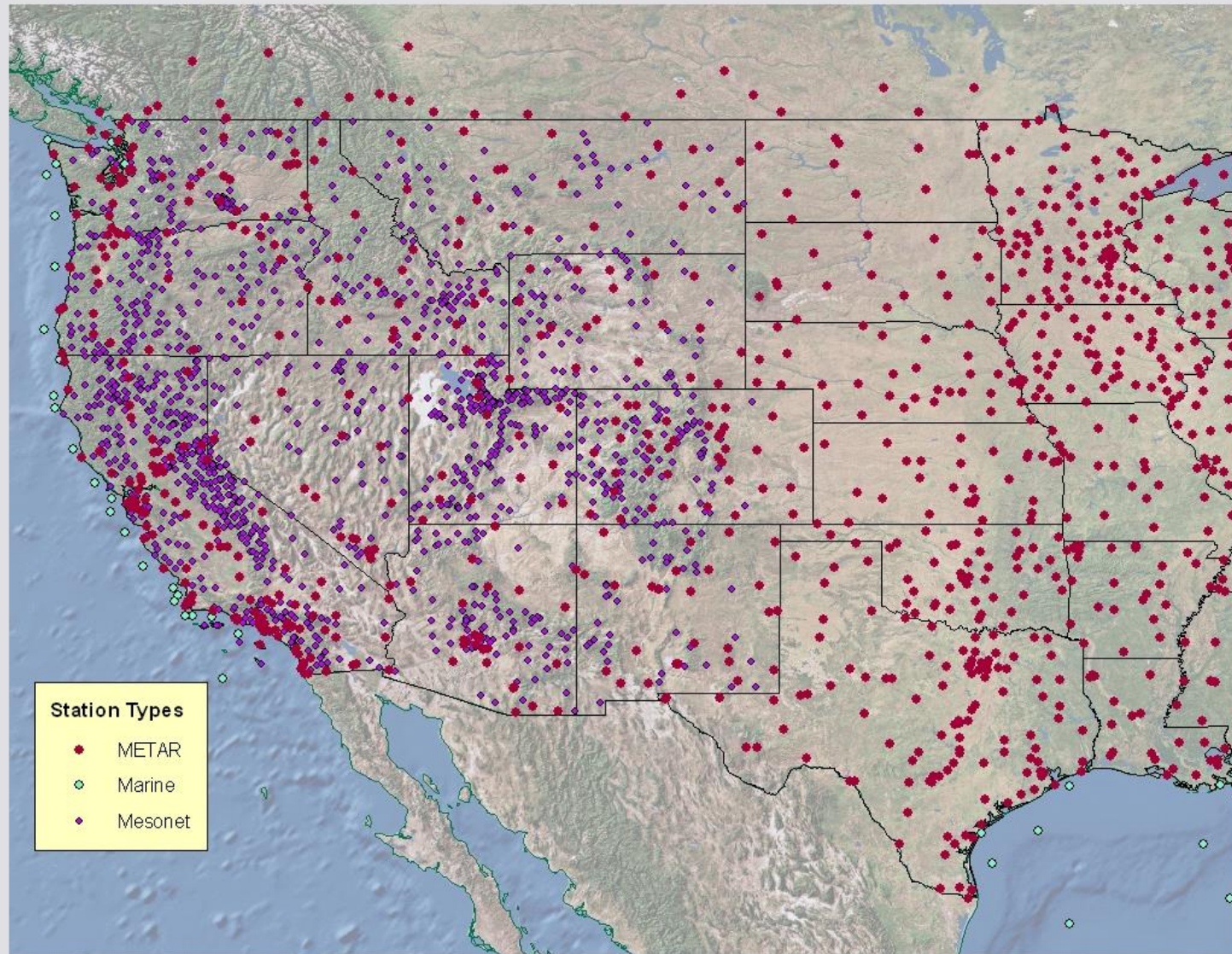


Elements

- Sky Cover
- Wind Gusts

MOS Stations available to analysis

METAR, Marine, Mesonet

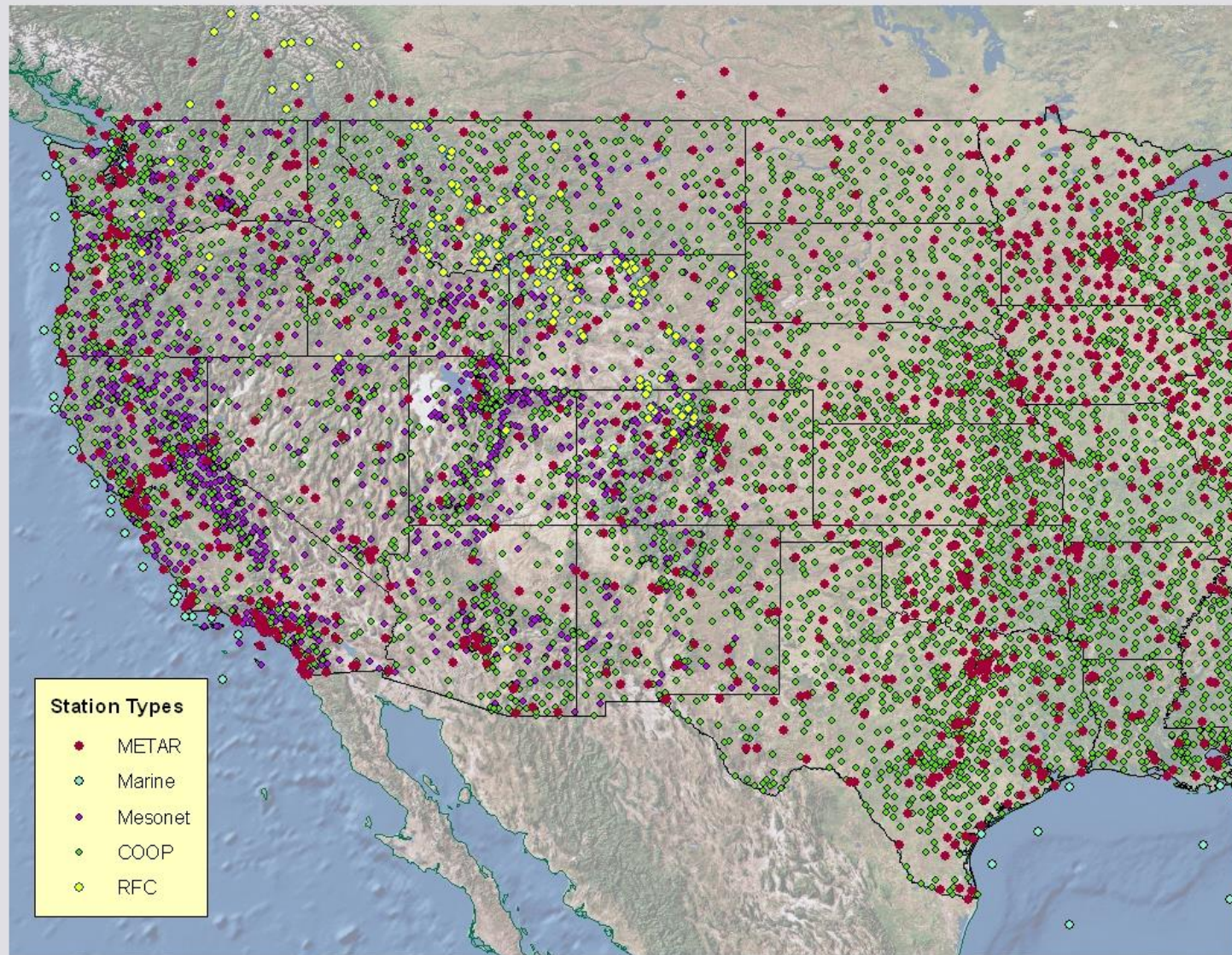


Elements

- Wind Direction
- Wind Speed
- 2-m Temperature
- 2-m Dew Point
- Relative Humidity

MOS Stations available to analysis

METAR, Marine, Mesonet, COOP, RFC



Elements

- Daytime Maximum Temperature
- Nighttime Minimum Temperature

TWO METHODS OF PROVIDING GRIDDED MOS

- Develop in such a way that forecasts can be produced directly at gridpoints
 - Regional Operator Equations (RO)
 - Generalized Operator Equations (GO) - (One big region)
 - RO and GO forecasts not as accurate as single station
 - RO equations applied to a fine scale grid produce discontinuities between regions
- Develop for and apply at stations, and grid them
 - Successive Correction analysis (e.g., Cressman, Barnes)
 - Relatively simple and fast
 - Details of application vary with weather element
 - One or more passes over data, correcting the “current” grid by an amount determined by the difference between the analysis and the forecast

SUCCESSIVE CORRECTION

- Start with first guess
 - Can be a constant (generally doesn't matter what constant, except for error checking (e.g., a specified constant or the average of all values to be analyzed), or can be, for instance, a similar model field
 - Current analysis value at a station determined by interpolation (bilinear)
 - Difference between current analysis and forecast, with possibly an elevation correction, determines correction at nearby gridpoints within a radius of influence R according to one of three algorithms
 - R varies by pass
 - Approximately 35 to 40 on first pass and 15 to 20 on last pass

CORRECTION METHODS

- 3 Possible types of correction for each gridpoint
 - 1) Average contribution from all stations
 - 2) Weight contributions from all stations by distance between station and gridpoint
 - 3) Same as 2), except divide sum by sum of weights
- No. 3 used almost exclusively

SMOOTHING ALGORITHM

- Basic method
 - Average the point to be smoothed with average of the surrounding 4 (or 8) points, weighting the average by a specified factor
- Terrain-Following
 - Smoothing is not done across significant valleys and ridges (> 100 m elevation difference across the valley or ridge)
 - Smoothing across an island or spit of land is not done
 - Only land points involved in smoothing of land gridpoints
 - Only water points involved in smoothing of water gridpoints
 - High and low values for the forecasts can be smoothed or not with either 5- or 9-point smoother, depending on weather element and terrain differences.

ELEVATION ADJUSTMENT

- Based on average lapse rate at pairs of stations
 - Each station has a list of 60 to 100 neighboring stations that are close in horizontal distance but far apart in elevation
 - Neighboring stations determined by preprocessing the metadata and remain the same for all analyses
 - When analyzing, many of these neighbors may be missing, so lapse rate may not be calculated if too few neighbors
 - Lapse rate for each station is the sum of all forecast differences divided by the sum of elevation differences
- Pair always > 130 m separation in the vertical
- Pair may be up to 337.5 km away

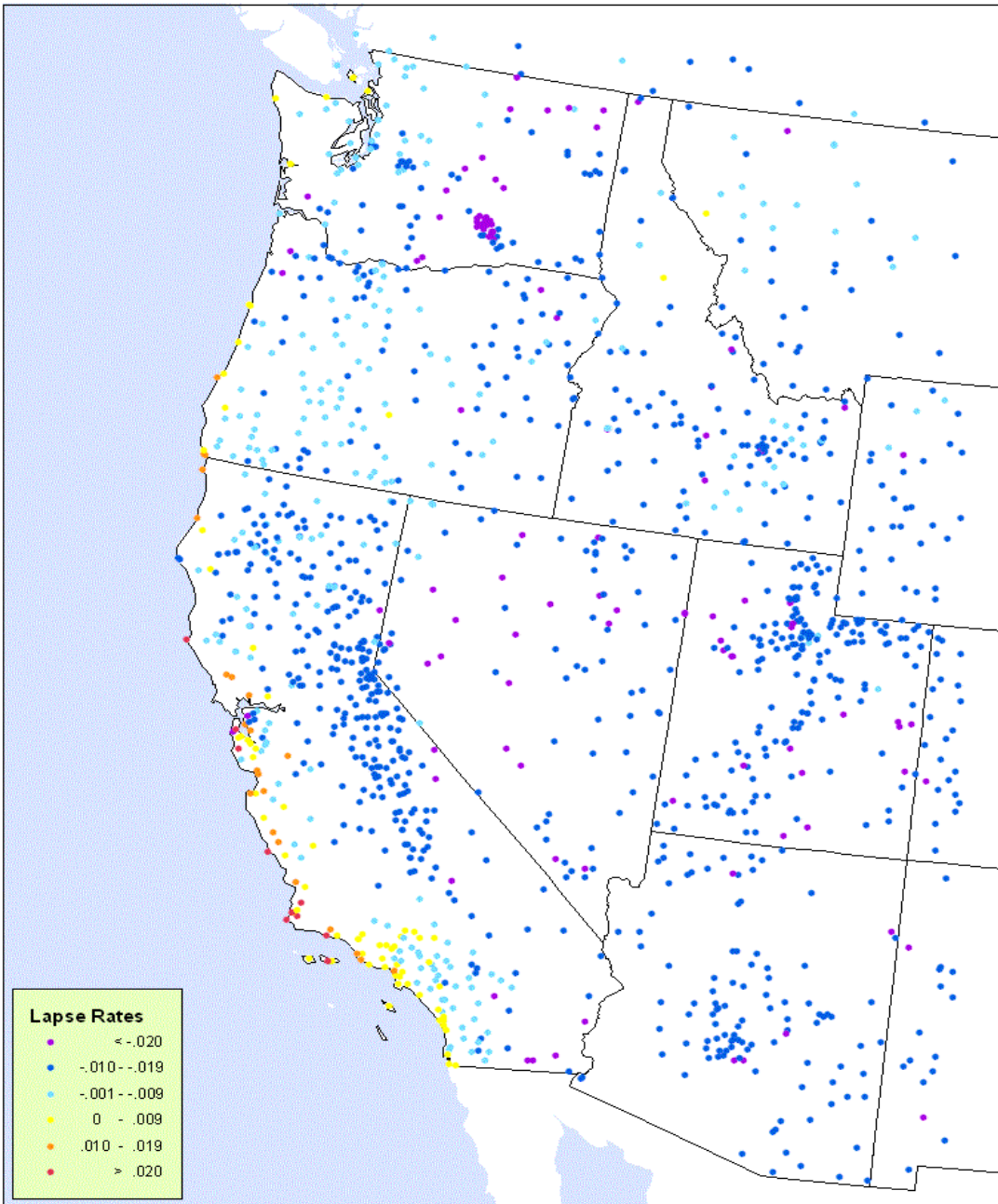
ELEVATION ADJUSTMENT

- Strength of elevation adjustment varies by pass
 - Generally full adjustment on Pass 1, with lesser on following passes
 - Last pass may have no adjustment
 - Adjustment can be both up and down, or only one way
- Elevation adjustment may not be used for some weather elements (e.g., U and V wind—used only for direction)

ELEVATION ADJUSTMENT

- “Unusual” lapse rates are limited
 - By strength of adjustment
 - By distance
- Temperature change with elevation usually negative, but may be positive along the west coast
- “Unusual” defined for each weather element

Unusual Lapse Rates



WATER VERSUS LAND

- Gridpoints are designated as either (1) Ocean, (2) Inland Water, or (3) Land
- Stations are designated as either (1) Ocean, (2) Inland Water, (3) Land, or (4) Both land and inland water
- Each type of station affects a corresponding type of gridpoint
 - Essentially three analyses in one
 - Interpolation recognizes difference

ERROR CHECKING

- Threshold defined for each weather element for each analysis pass
 - Difference between the current analysis and the forecast must be $<$ the threshold for the forecast to be used on that pass
 - But--Before discarding when threshold is not met, two nearest neighbors are checked, both with and without terrain adjustment
 - If one of the neighbors supports the questionable forecast, both are accepted
 - Nearest neighbor checking is expensive, but is used rarely and is highly effective

CATEGORICAL VARIABLES

- Analysis is designed for continuous fields
 - Many MOS forecasts are developed as probabilities of categories of the weather variable (e.g., snow amount, precipitation amount, sky cover), then a “best category” determined based on reasonable bias and some skill or accuracy score
 - Necessary because of highly non-normal distribution and the heavy tail is the important part of the distribution
 - Best category forecasts used with the probabilities of those forecasts to calculate a near continuous set of values to analyze

CATEGORICAL VARIABLES

- Categorical values are scaled between the two extremes of the category based on the maximum and minimum values of the probabilities over the grid for that category.
- Extreme value has to be assumed for the end category
 - Highest category of 6-h QPF is one inch and above
 - 2 inches chosen as the high value
- Elevation correction can adjust amounts outside category, even at high end.

CONSISTENCY IN SPACE AND TIME

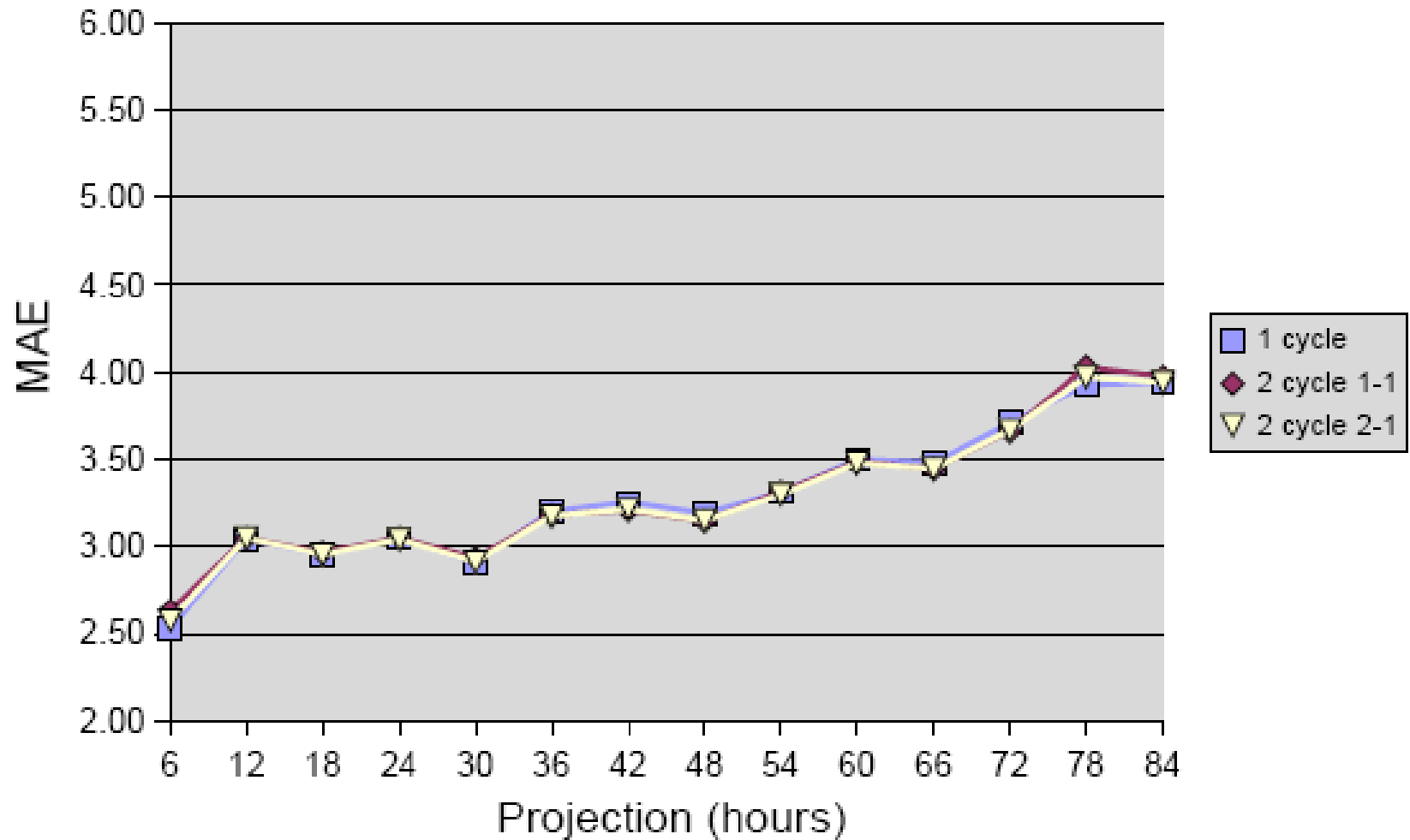
- Looped graphics of grids produced from MOS forecasts for different cycles “pulse”
 - Equations developed at different times with different samples
 - Equations have different predictors
 - Basic model may exhibit cycle differences
 - Different set of stations for different cycles
- Analyses are based on average values from two cycles, 12 hours apart.
 - Essentially an ensemble of two
 - Verification against observations shows no deterioration with this process
 - Much improved time and space continuity

FIT TO DATA 2-M TEMPERATURE

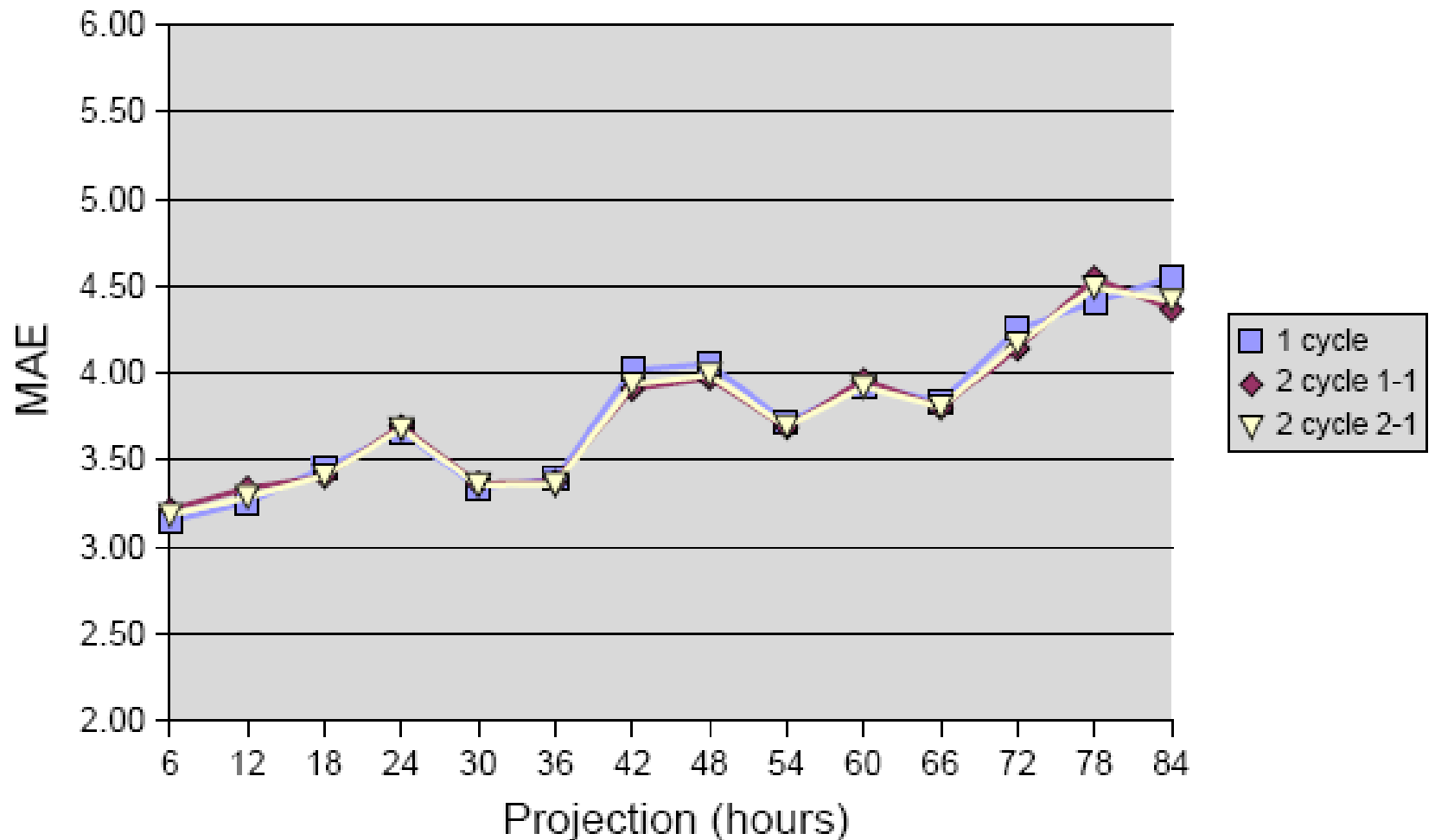
MAE DEG F

- Over United States without elevation With elev
 - Analyzed 1.92 1.43
 - Withheld 2.55 1.94
- Over West (approx. west of 105 deg. W)
 - Analyzed 2.91 2.04
 - Withheld 4.43 2.72

Surf T MAE (Not Withheld)



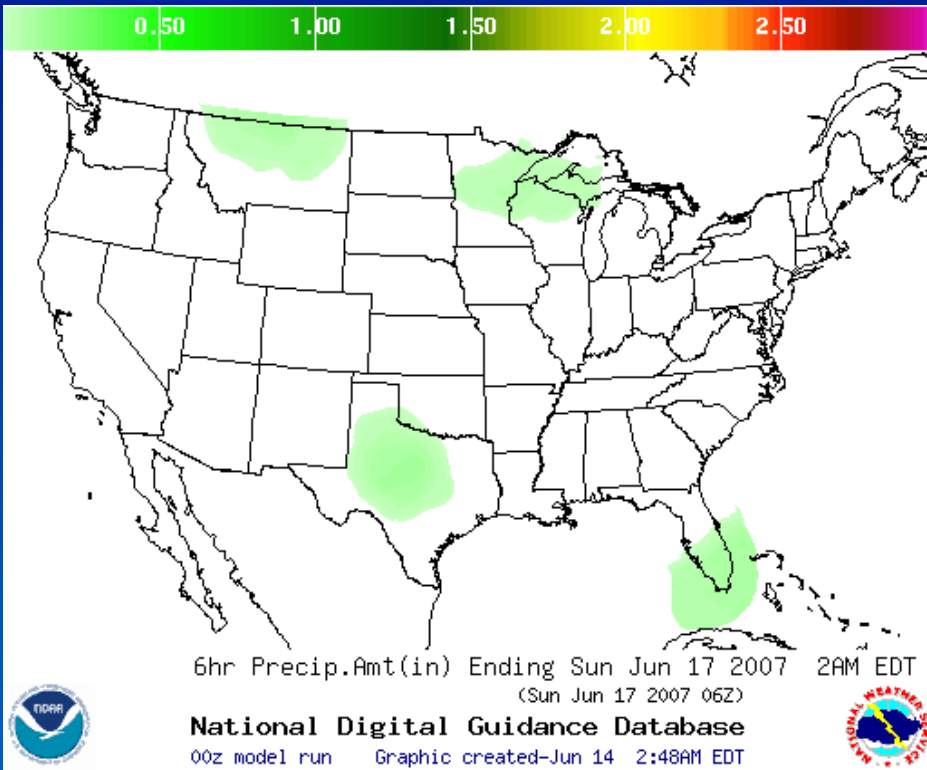
Surf T MAE (Withheld)



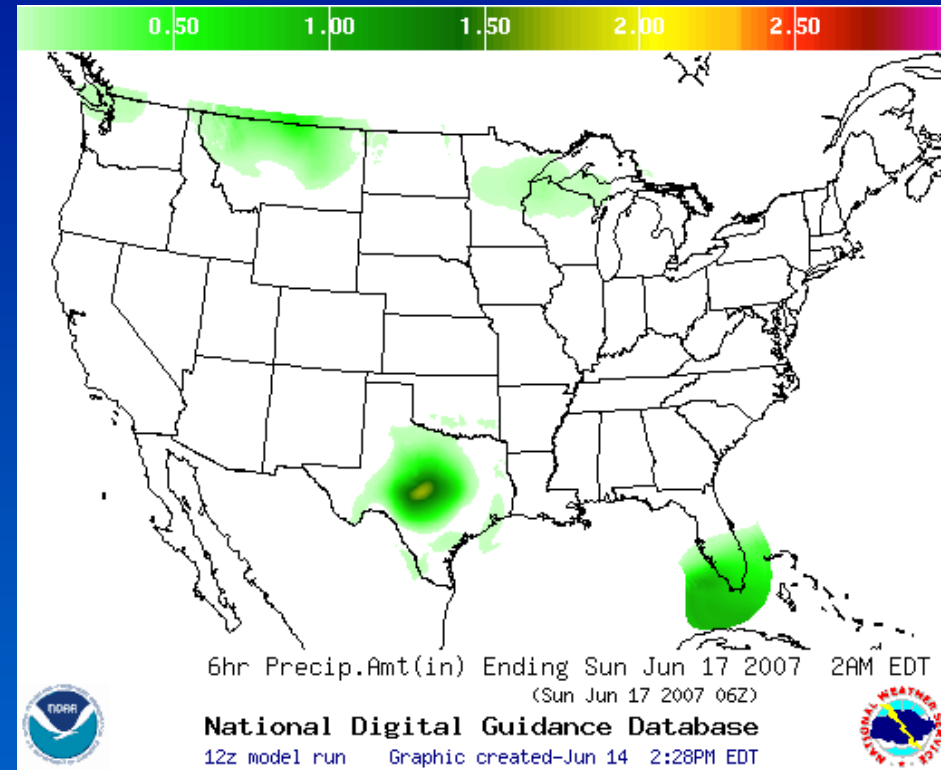
CONSISTENCY AMONG WEATHER ELEMENTS-POSTPROCESSING

- Consistency not dealt with in the analysis procedure
- Postprocessing of grids
 - Temperature and dew point
 - 12-h QPF calculated from two 6-h amounts
 - Wind “gust” grid a combination of wind speed and gusts
 - Wind direction calculated from U and V

Precipitation Amount Modification



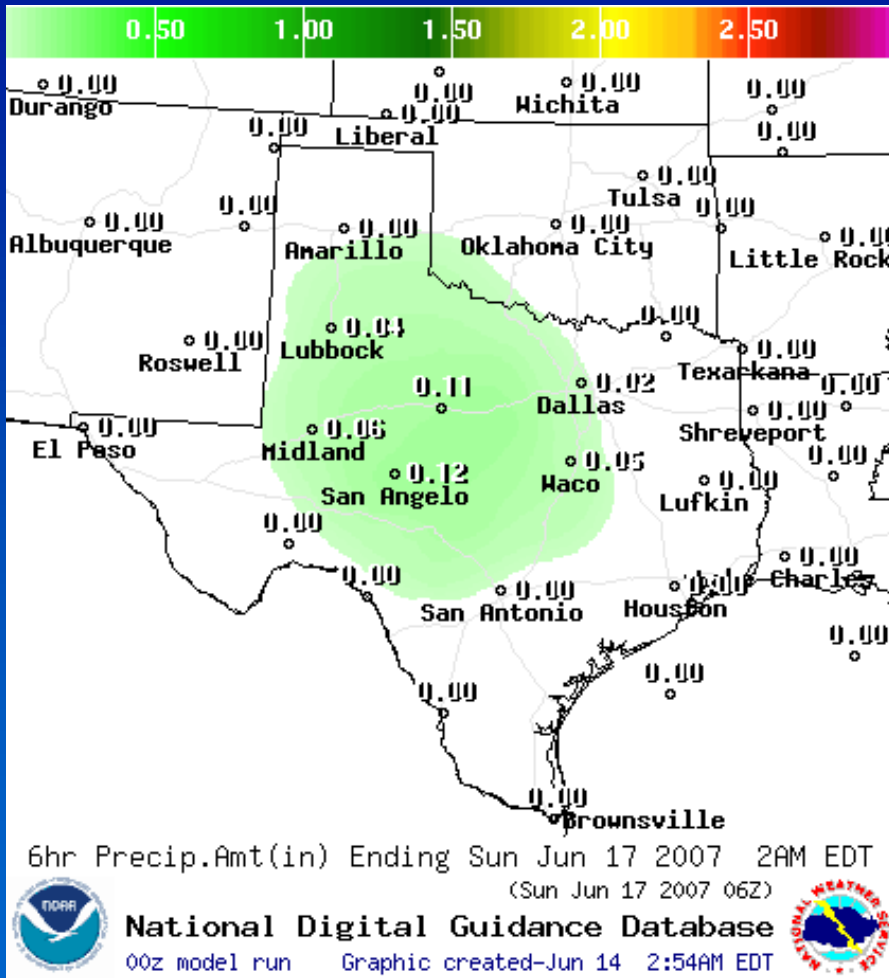
Current Method



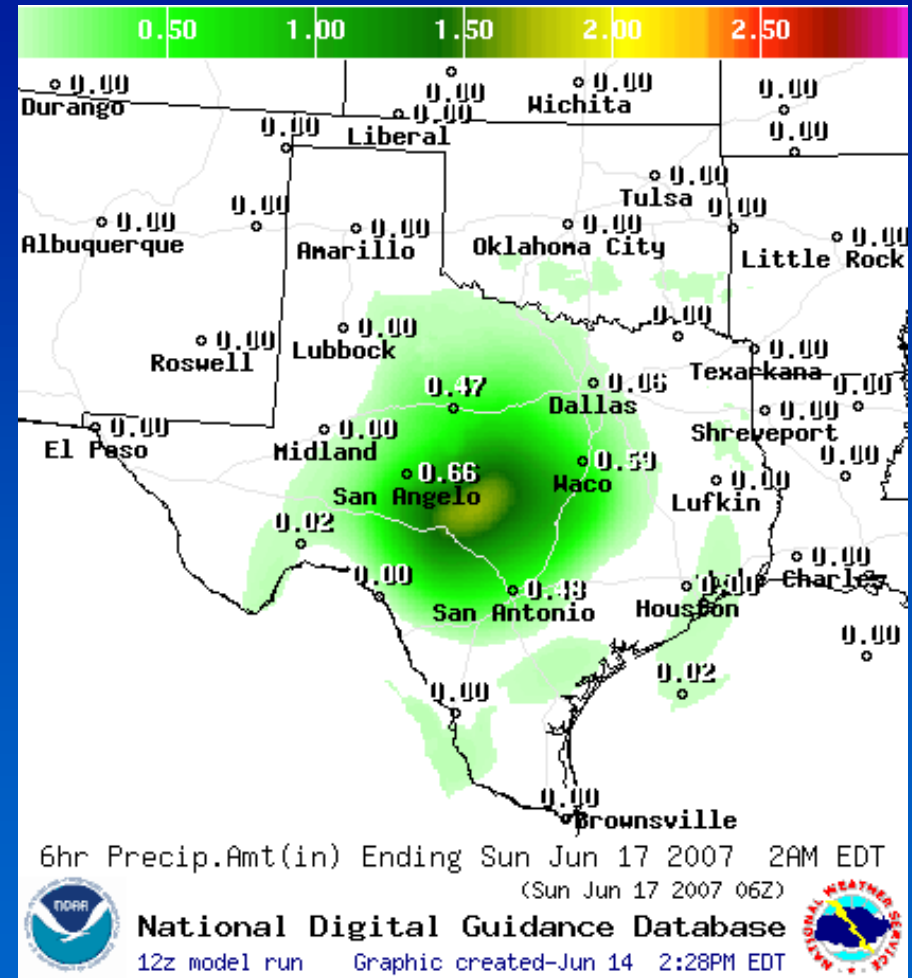
New Method

- Changed from an expected value to a computed amount based on an adjustment of the categorical forecast. This will increase the amounts.

Precipitation Amount Modification



Current Method



New Method

- Changed from an expected value to a computed amount based on an adjustment of the categorical forecast. This will increase the amounts.

Future Upgrades

- **Alaska guidance on 3-km grid**
 - Initial release: temperatures, winds, probability of precipitation (PoP)
 - Later releases: QPF, snow, sky cover, wind gusts, thunderstorms, weather, precipitation type, 6-h snow
- **Hawaii, Puerto Rico guidance on 2.5 km grid**
 - Initial release: temperatures, winds, PoP
 - Later releases: QPF, sky cover, wind gusts
- **CONUS guidance on 2.5 km grid**
 - Initial release: temperatures, winds, PoP
 - Later releases: QPF, snow, sky cover, wind gusts, weather grids, precipitation type, 6-h snow
- **Guam guidance**
 - Still in planning stages